
Folate Intake and Supplement Use in Women of Childbearing Age

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Data from the 1994-95 Continuing Survey of Food Intakes by Individuals were analyzed to determine folate intake and supplement use by women of childbearing age (11 to 50 years old). We identified the primary food sources of folate and mean folate intake from two nonconsecutive 24-hour recalls and examined characteristics of supplement users of B vitamins. Top sources of folate were ready-to-eat cereals, citrus fruits and juices, grain mixtures, and yeast breads. Mean dietary folate was $215 \pm 3 \mu\text{g}$. On a daily basis, one of four women consumed supplements containing B vitamins. Thirty-two percent of women consumed at least $400 \mu\text{g}$ folates from food and/or daily supplements. Compared with nonusers, daily supplement users were more likely to be White, older, more educated, frequent exercisers, and have higher income. Results suggest that nutrition educators may be more successful encouraging women to consume additional servings of fortified-grain products rather than encouraging women to add folate-rich foods or supplements to their diet.

Neural tube defects are serious birth defects that can result in infant mortality or serious disability. Each year in the United States about 4,000 infants are born with neural tube defects such as spina bifida, which has the third highest lifetime cost of any birth defect (11). Thus, there is continual need to identify modifiable risk factors that can prevent this defect. Adequate folic acid status is potentially an ideal modifiable risk factor, because folate coenzymes function metabolically in the synthesis of RNA, DNA, and protein in the developing fetus (27,33,37).

To prevent neural tube defects, women need to achieve optimal folate status before pregnancy occurs, because the neural tube forms and closes during the

first month of pregnancy. Increasing folate intake by diet and supplements before conception and in the first 6 weeks of pregnancy has been shown to protect against the occurrence of neural tube defects (6,13,28,29).

Adequate folate intake is especially important for women with a history of a pregnancy with a neural tube defect. Recurrence rates for women with a previously affected pregnancy are about 10 to 15 times higher than those for the general population (39). However, 95 percent of infants with neural tube defects are born to women without a family history of the defects (4). Because about half of pregnancies are unplanned or mistimed (20), adequate folate intake is important for all women who can become pregnant.

Women in their childbearing years consume less than the recent recommendations for folate: at least 400 µg per day of folic acid to reduce the risk of neural tube defects (9,10). Data from the Third National Health and Nutrition Examination Survey (NHANES) and the 1989-91 Continuing Survey of Food Intakes by Individuals (CSFII) have shown that most women of childbearing age consumed about half the recommended amount of folates (1,38). Subar et al. (45) found that 93 percent of women surveyed in the NHANES II consumed less than the recommendation. In the 1986 CSFII, less than 10 percent of women met the recommended 400 µg folate per day, and only about 30 percent of low-income women and 50 percent of higher income women met the 1989 Recommended Dietary Allowance (180 µg) (30) from food sources (5).

This study examines folate intake—from food and supplement use—of a sample of households with women of childbearing age. Understanding the existing patterns of folate intake and characteristics of women who consume supplements will allow researchers and others to evaluate the potential effects associated with changes in diet or supplement use among women.

Subjects and Methods

We examined the foods consumed by 2,086 women of childbearing age (11 to 50 years old) who completed two 24-hour dietary recalls in the U.S. Department of Agriculture's (USDA) 1994-95 CSFII. The CSFII provides information on nutrient intakes and a number of demographic, socioeconomic, and personal characteristics. To identify participants, the survey incorporates a stratified, multistage sampling plan.

Subjects are noninstitutionalized individuals grouped by gender, age, and income level. Details of the study design and recruitment of CSFII participants are described in detail elsewhere (49).

Food Sources

USDA food codes classify foods into 11 major food groups: Milk and milk products; meat, poultry, and fish; eggs; legumes; nuts and seeds; grain products; fruits; vegetables; fats; sugars and sweets; and beverages. The USDA food codes also identify 59 subgroups within 8 of the major food groups. For example, vegetables are divided into 8 subgroups (white potatoes; dark-green vegetables; deep-yellow vegetables; tomatoes; lettuce; green beans; corn, green peas, and lima beans; and other vegetables). Eggs, legumes, and nuts and seeds do not contain subgroups.

To determine whether to use a major food group or subgroup for this analysis, we identified the five foods in each subgroup most frequently consumed by the women of childbearing age who were included in this study. The CSFII Survey Nutrient Data Base was used to determine the amount of folate in a serving of each identified food (49). If the amount of folate in the foods in the subgroups was similar, we used only the major food group. For example, skim milk and whole milk contain about the same amount of folate (12 µg), so we reported all fluid milk as one group.

If the amount of folate in the subgroups was substantially different, we used each subgroup separately. For example, ready-to-eat cereals (44 µg) and rice (2 µg) were analyzed as separate grain subgroups. We selected 38 food groups and subgroups from 70 possible groups

and subgroups. The total amount of folate in each of the selected groups was divided by the total folate intake from all foods (45), and foods were ranked by percentage contribution to dietary folate intake (table 1). To determine the percentage of women who consumed each food, we grouped those who consumed any amount of the food and those who did not consume the food during the two 24-hour recalls.

Statistical Analysis

Using SPSS software (42), we compared differences in mean dietary folate intake among women based on their descriptive characteristics. T-tests compared folate intake by ethnic origin, weight-loss diet, smoking status, and use of food stamps. Analysis of variance (ANOVA) with Scheffe range tests compared folate intake by race, pregnancy/lactation status, supplement use, household income (expressed as a percentage of the Federal poverty index), and exercise frequency. Pearson coefficients were used to correlate folate intake from food with mean grams of foods consumed, level of education, energy intake, and body mass index (BMI).

We described the characteristics of women who used supplements containing B vitamins (daily, every so often, and never) using ANOVA and Chi-square analyses. We used normalized 2-day sample weights (49), and we reported means and standard error of the mean (SEM). Differences were considered statistically significant at the $p < 0.01$ level—a more conservative level than standard practice—to compensate for the effects of the large sample size and complex design (49).

Results

Food Sources

For 11- to 50-year-old women in this study, the major sources of folate were ready-to-eat cereals, citrus fruits and juices (predominately orange juice), grain mixtures such as pizza, and yeast breads (table 1). Ready-to-eat cereals contributed 20 percent of total folates to the women's diet; citrus fruits and juices, 8 percent; grain mixtures, 7 percent; and yeast breads, 6 percent. Some of the other top contributors of folate (e.g., milk, nonalcoholic beverages, and white potatoes) are not rich sources of this vitamin, but these foods were consumed by most women during the two nonconsecutive 24-hour dietary recalls (64 to 95 percent). Other foods that are naturally rich sources of folate (e.g., dark-green vegetables and liver) did not contribute as much folate to the diet, because few women consumed these foods.

The foods that correlated most strongly with folate intake were ready-to-eat cereals, citrus fruits and juices, fluid milk, and legumes, such as beans (refried and pinto). For example, women who consumed less than 120 µg folates ate almost no (0.4 g) ready-to-eat cereals; however, women who consumed at least 400 µg folates ate, on average, 46.8 g of ready-to-eat cereals per day. (Data are not shown.)

Folate Intake by Characteristics

Overall, only 8 percent of the women of childbearing age consumed more than 400 µg folate per day (the new recommendation) (figure). Mean folate intake was 215±3 µg, and median intake was 189 µg. (Data are not shown.) About half (47 percent) of the women consumed less than the 1989 RDA of

Table 1. Sources of folate in the diets of U.S. women of childbearing age¹ and correlation between grams of food consumed and folate intake, 1994-95 CSFII

Food group ²	Percent of total folate ³	Percent of women who consumed food ⁴	r
Ready-to-eat cereals	19.7	34.6	0.59***
Citrus fruits and juices	7.6	36.7	0.35***
Mixtures mainly grains	6.5	60.7	0.08***
Total yeast breads and rolls	6.2	82.4	0.11***
Mixtures mainly meat, poultry, fish	5.1	56.4	0.09***
Other vegetables (including brewer's yeast)	4.5	62.5	0.13***
Legumes	4.5	22.0	0.25***
Fluid milk	4.4	67.6	0.36***
Nonalcoholic beverages	4.1	95.2	0.09***
White potatoes	4.0	63.5	0.00
Lettuce	3.5	42.3	0.15***
Cake, cookies, pastries, pies	3.3	56.1	0.10***
Dark-green vegetables	3.1	16.7	0.17***
Other fruits, mixtures, juices	3.0	50.0	0.20***
Corn, lima beans, green peas	2.3	20.3	0.12***
Eggs	2.3	28.6	0.03
Crackers, popcorn, pretzels, corn chips	1.8	43.4	0.15***
Tomatoes	1.6	57.5	0.13***
Nuts, seeds	1.3	13.9	0.11***
Quick breads, pancakes, french toast	1.3	36.4	0.09***
Alcoholic beverages	0.9	13.8	0.06***
Beef	0.9	35.7	0.02
Cheese	0.8	52.4	0.09***
Green beans	0.8	13.1	0.04
Poultry	0.8	40.5	-0.05
Milk-based desserts	0.7	25.0	0.12***
Sugar	0.7	69.1	0.06***
Organ meats (e.g., liver)	0.5	0.8	0.11***
Deep-yellow vegetables	0.5	21.7	0.11***
Pasta	0.5	13.5	0.07***
Fish, shellfish	0.5	13.7	0.01
Yogurt	0.4	7.0	0.11***
Rice	0.4	19.5	0.05
Frankfurters, sausages, luncheon meat	0.3	40.6	-0.03
Fat	0.3	72.0	0.11***
Pork	0.2	23.6	-0.01
Lamb, veal, game	0.1	1.6	0.01
Dried fruits	0.0	2.2	0.14***

¹Women 11 to 50 years old who completed two nonconsecutive 24-hour recalls; n=2,086.

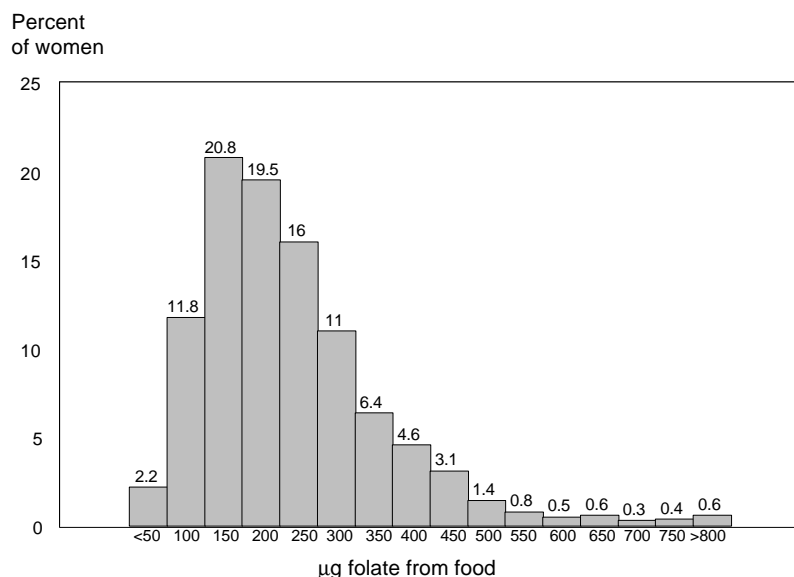
²Food groups and subgroups that provided 99 percent of the sample's folate intake.

³The total amount of folate in each group was divided by the total folate intake from all foods consumed by all women during the two 24-hour recalls.

⁴Percentage of women who consumed any amount of the food during the two 24-hour recalls.

***Significant correlation between grams of food consumed and folate intake, $p \leq 0.001$.

Dietary folate intake (μg) of women¹ 11 to 50 years old, 1994-95 CSFII



¹Women who completed two nonconsecutive 24-hour recalls.

The foods that correlated most strongly with folate intake were ready-to-eat cereals, citrus fruits and juices, fluid milk, and legumes, such as beans (refried and pinto).

180 μg folate per day from food sources. (Data are not shown.) Also, analysis of folate intake by the women's characteristics showed that Blacks had lower intakes than Whites had (table 2). Women who were breast-feeding consumed more folate from their diet than other women consumed. Results also revealed that subjects with higher incomes, those who did not receive food stamps, and nonsmokers consumed more folate than did their counterparts. Women's folate intake was not statistically different based on several characteristics: Ethnic origin, exercise frequency, BMI (not shown), and whether the women followed a weight-loss diet. However, further analysis showed that dietary folate was related positively to energy intake ($r=.42$, $p < 0.001$).

Supplement Use

Daily, about one-fourth (27 percent) of the women consumed a dietary

supplement containing folate, and 15 percent occasionally consumed this supplement. Only 9 women reported consuming a separate folic acid supplement; all other supplement users took a multivitamin or B-complex vitamin. Women who took daily supplements containing B vitamins consumed significantly more folates from food than did women who occasionally or never consumed supplements (table 3). Of the 161 women who consumed at least 400 μg folates from food, 42 percent also took daily supplements. In all, 32 percent ($n=661$) of the total sample met the recommendation by diet and/or daily consumed supplements. (Data are not shown.)

Women who consumed supplements daily were significantly more likely to be older and more educated than were women who never took supplements.

Table 2. Differences in mean folate intake (μg), by demographic characteristics of women 11 to 50 years old,¹ 1994-95 CSFII

Characteristic	N	Mean \pm SEM	P
Race			0.001
White	1601	219.6 \pm 3.4 ²	
Black	284	188.5 \pm 7.2 ³	
Other	201	214.9 \pm 8.3 ^{2,3}	
Origin			NS
Non-Hispanic	1851	213.1 \pm 3.0	
Hispanic	235	228.8 \pm 8.9	
Reproductive status			<0.001
Pregnant	47	249.0 \pm 20.0 ²	
Lactating	33	337.8 \pm 34.1 ³	
Not pregnant or lactating	2006	212.1 \pm 2.9 ²	
Receiving food stamps			<0.001
Yes	269	182.1 \pm 7.1 ²	
No	1817	219.8 \pm 3.1 ³	
Income (% of poverty index)			<0.001
<130%	432	197.9 \pm 6.2 ²	
130-350%	861	208.6 \pm 4.2 ²	
>350%	793	231.0 \pm 5.0 ³	
Smoking status			0.001
Smoker	749	201.8 \pm 4.6 ²	
Nonsmoker	1337	222.3 \pm 3.7 ³	
Following a weight-loss diet			NS
Yes	145	207.2 \pm 10.8	
No	1941	215.5 \pm 3.0	
Exercise frequency			NS
Daily	294	209.4 \pm 7.5	
5-6 times a week	162	239.5 \pm 11.6	
2-4 times a week	539	219.7 \pm 5.3	
Once a week	194	223.0 \pm 10.6	
1-3 times a month	153	203.3 \pm 8.5	
Rarely	744	208.5 \pm 4.9	

¹Women 11 to 50 years old who completed two nonconsecutive 24-hour recalls; n=2,086.

^{2,3}Values in the same column with different superscript numbers are significantly different, $p < 0.01$.
NS = not significant.

Those women who consumed supplements daily were also more likely to be White, be pregnant or lactating, have higher income, and be more frequent exercisers. However, they were less likely than women who never consumed supplements with folate to receive food stamps. Frequency of supplement use was not related significantly to women's energy intake, BMI, ethnic origin, smoking status, and weight-loss diet status.

Discussion

Three approaches to increasing folate intake in women are to increase their consumption of folate-rich foods, add folic acid to fortified grain products they consume, or encourage women to take supplements containing folic acid (14,27,31,35,38). Our study provides results that address all three approaches.

Food Sources

In our study, we found that the foods which provided the most folate for women of childbearing age are similar to the major sources of folates reported in earlier national studies; however, the foods appear in a different order. Our results show that ready-to-eat cereals provide about 20 percent of the folate consumed by these women. The top 10 contributors of folate (when regrouped according to USDA food groups) for all adults in NHANES II were citrus fruit and juice, bread, cold cereals, legumes, green salad, fluid milk, eggs, alcoholic beverages, coffee and tea, and liver (45). Top contributors of folate for women who participated in the 1987-88 Nationwide Food Consumption Survey were vegetables; ready-to-eat cereals; meat, fish, poultry; grains; other foods; desserts and snacks; orange juice; other beverages; milk; and fruit (38). The Framingham Study showed that the top

Table 3. Frequency of intakes of vitamin B supplement, by demographic characteristics of women 11 to 50 years old, 1994-95 CSFII

	Frequency of supplement use						P
	Daily (n=567)		Every so often (n=303)		Never (n=1216)		
	Mean ± SEM		Mean ± SEM		Mean ± SEM		
Folate from food (µg)	240.1 ± 5.7 ¹		212.1 ± 6.9 ²		203.9 ± 3.7 ²		<0.001
Age (years)	32.6 ± 0.4 ¹		29.8 ± 0.6 ²		29.4 ± 0.3 ²		<0.001
Education (years)	13.8 ± 0.1 ¹		13.6 ± 0.2 ¹		12.8 ± 0.1 ²		<0.001
Energy (kcal)	1765 ± 26		1756 ± 34		1692 ± 18		NS
BMI (kg/m ²)	26.8 ± 0.6		25.7 ± 0.7		27.7 ± 0.5		NS
	N	%	N	%	N	%	
Race							<0.001
White	475	83.8	237	78.2	889	73.0	
Black	51	9.0	37	12.2	197	16.2	
Other	41	7.2	29	9.6	131	10.8	
Origin							NS
Non-Hispanic	514	90.7	263	86.8	1074	88.2	
Hispanic	53	9.3	40	13.2	143	11.8	
Reproductive status							<0.001
Pregnant	38	6.7	2	0.7	7	0.6	
Lactating	22	3.9	2	0.7	10	0.8	
Not pregnant or lactating	507	89.4	299	98.7	1199	98.6	
Receiving food stamps							<0.001
Yes	52	9.2	24	7.9	193	15.9	
No	515	90.8	278	92.1	1024	84.1	
Income (% of poverty index)							<0.001
<130%	90	15.8	46	15.2	296	24.3	
131-350%	231	40.7	125	41.4	505	41.5	
>350%	247	43.5	131	43.4	415	34.1	
Smoking status							NS
Smoker	214	37.7	115	38.0	421	34.6	
Nonsmoker	353	62.3	188	62.0	796	65.4	
Following a weight-loss diet							NS
Yes	47	8.3	21	6.9	77	6.3	
No	519	91.1	282	93.1	1139	93.7	
Exercise frequency							<0.001
Daily	83	14.6	35	11.6	176	14.5	
5-6 times a week	42	7.4	27	8.9	92	7.6	
2-4 times a week	172	30.3	88	29.0	279	22.9	
Once a week	67	11.8	31	10.2	96	7.9	
1-3 times a month	32	5.6	36	11.9	85	7.0	
Rarely	171	30.2	86	28.4	488	40.1	

^{1,2}Values in the same row with different superscripts are significantly different, $p < 0.01$.

NS = not significant.

...27 percent of women of childbearing age consumed supplements containing B vitamins daily; these women consumed more folate than did women who did not take supplements.

food sources of folates for elderly subjects were citrus fruit and juice, cold cereals, lettuce, dark-green vegetables, bread, other vegetables, grain mixtures, fruits, and milk (47).

The richest food sources of folates in the U.S. food supply are liver, ready-to-eat cereals, legumes, and dark-green vegetables (2,45). Few women in our study ate these folate-rich foods, the exception being ready-to-eat cereals. Other foods, such as orange juice, contain moderate amounts of folates but are major contributors to the diet because of the frequency and quantity with which they are consumed (2).

An important point to make is this: nutrient databases (including the USDA database used in this study) are believed to provide an inaccurate estimate of folate intake. The database values are thought to underestimate actual folate content, because of the limitations of traditional analytical methods used in generating the food composition data for folate (18).

For women to receive all of the needed folate from food sources, they need to consume at least the minimum number of servings from each food group, as recommended by the Food Guide Pyramid (17,48), and select good sources of folates within each food group (5,23,33). For example, according to the 1989-91 CSFII, about one-third of women who consumed folate-rich, ready-to-eat cereals met the 400 μ g folate recommendation; less than 5 percent of women who did not consume cereal met the recommendation (38). Krebs-Smith et al. (23) found that less than 1 percent of women in the United States consumed the recommended

number of servings from all food groups; only 27 percent consumed the recommended number of grain products.

Beginning in January 1998, enriched cereal-grain products in the United States were fortified to provide 140 μ g per 100 g of product (17). This amount of fortification is estimated to add about 100 μ g folic acid per day to the average U.S. diet (22,31,46). The Food and Drug Administration (FDA) allows breakfast cereals to be fortified with folic acid up to 400 μ g per serving, but this is being monitored to determine how widespread this practice becomes (16).

Several recent studies explored the potential benefits of fortifying grain products with folic acid. Folic acid from fortified foods was more effective in increasing the concentration of red blood cell folate than equivalent amounts of naturally occurring folate (18). Pfeiffer et al. (32) provided evidence of effective absorption of folic acid that is added to grain foods in a light meal. Their conclusion: folic acid absorbed from fortified foods should improve the folate status of the population.

Two studies of the potential benefits of folic acid fortification (34,46) recently estimated that the level of fortification recently approved by the FDA would increase the percentage of the population who consume at least 400 μ g folate to about 50 percent. Daly et al. estimated that this level of fortification would decrease the incidence of neural tube defects by 50 percent (14). However, because many women limit energy intake and grain consumption, the influence of fortification may be less in this high-risk group than in other groups.

Folate Intake by Characteristics

We found that women with higher energy intakes consume more folate; however, women who report following a weight-loss diet consume the same amount of folate as women who did not acknowledge following such a diet. This indicates that women on weight-reduction diets may select more foods that are good sources of folates. However, the significant correlation between energy and folate intake indicates that women who restrict their energy intake (even if they do not acknowledge following a weight-loss diet) are less likely than their counterparts to consume enough folate. Other researchers found that the chance of having an inadequate folate intake is greater for women with the following characteristics: Low socioeconomic status, poor eating habits, stringent dieting for weight loss, abuse of drugs or alcohol, and smoking cigarettes (5,21,33,36). We also found that smokers consumed less folate than nonsmokers, and lower income women consumed significantly less folate than was the case for higher income women.

Supplement Use

In our study, we found that 27 percent of women of childbearing age consumed supplements containing B vitamins daily; these women consumed more folate than did women who did not take supplements. About 25 percent of the women in the 1992 and 1987 National Health Interview Surveys consumed supplements daily (40,41,44). Similar to our study, the studies of other researchers show that most adults take one broad-spectrum vitamin/mineral supplement rather than a single nutrient (7,25,43). The National Health Interview Surveys also found that daily supplement use was highest among Whites, those with higher incomes, and those with more than a high school education (40,41,44). A study of the Dutch population found

that age, social class, alternative food habits, smoking, and dieting were all related to the use of supplements (15). However, we did not find significant relationships between dieting or energy intake and how often the women used supplements.

Women in our study who took supplements daily consumed significantly more folate in their diets than did women who took supplements less often or never. The mean intake for all groups was, however, less than the recommended amount of folate. Women in the National Health Interview Survey who took supplements had diets that were significantly more healthful (lower in fat and higher in fiber, calcium, and vitamins A, C, and E) than non-users had (40). Others reported similar findings (3,7,24,26).

Supplemental folic acid in doses up to 1,000 µg per day is considered non-toxic to healthy adults (8,18). Folic acid in supplements is about twice as available as naturally occurring folates because folic acid can be absorbed intact, while folates must be broken down before absorption (19,37). The folic acid in supplements may be most beneficial to women who limit their dietary selection: such as women who avoid folate-rich foods or restrict their energy intake (39). Providing supplementation to the target group is likely to cause the least harm to others (35). Despite the effectiveness and safety of folic acid supplements, this approach probably will have only a small influence on decreasing the incidence of neural tube defects because most women are unlikely to take a supplement before they become pregnant (14,27). A recent study in London found that only 3 percent of pregnant women had taken folic acid supplements before conception when it would have been most beneficial (12).

Implications

Our study provides evidence, from a recent national survey, that can be used to help nutrition educators and policy-makers in addressing inadequate folate intake by women of childbearing age. Increasing folate intake by encouraging women to add foods that are naturally rich in folate is a challenge for nutrition educators. Perhaps, a more successful approach is to encourage women to substitute good sources of folate for low-folate choices (e.g., orange juice instead of apple juice) or consume an additional serving of fortified grain products rather than add a folate-rich food such as a dark-green vegetable that few women eat.

Encouraging all women of childbearing age to take supplements containing folic acid is another approach to improving folate status in this high-risk group. Our findings confirm the results of other studies on supplement use; women who take supplements are less likely to need additional folate than women who do not take supplements.

Future research should identify the best strategies to use when shaping nutrition interventions to increase women's intake of foods that are naturally rich or fortified with folates or to increase women's use of folic acid supplements. In addition to having information on the foods that are being consumed and the demographic characteristics that influence supplement use, we need to understand better the behaviors and environmental factors that shape food intake and supplement use. Then interventions and nutrition education programs can be designed that result in increased intake of folates.

Acknowledgment

This project was funded in part by the Oklahoma Agricultural Experiment Station project OKLO/2283.

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